## SAND FILTER DETAILED KCRTS ROUTING METHOD WORKSHEET

2005 Surface Water Design Manual

METHODS OF ANALYSIS (Section 6.5.2.1) Detailed KCRTS Routing Method  Step 1) Determine whether a basic or large sand filter is needed.  Basic or Large Sand Filter?  See Section 1.2.8 (map) and Section 6.1 (menus) %runoff volume to be treated  90% for basic and 95% for large  Step 2) Determine rainfall region and regional scale factor.  Rainfall Region: Landsburg or Seatac? Regional Scale Factor:  (unitless)  Required Figure 3.2.2.A Regional Scale Factor:  (unitless)  Required Figure 3.2.2.A Regional Scale Factor:  If the sand filter is upstream of detention, the time series is that of the developed site.  If the sand filter is downstream of detention, the time series is that leaving the detention pond.  In KCRTS at the main menu, select "CREATE a new time series" to generate the inflow time series Select project location  Seatac or Landsburg  Enter Till Grass  [acres] Enter Till Grass  [acres] Enter Till Grass  [acres] Enter Outwash Pasture [acres] Enter Outwash Forest [acres] Enter Outwash Grass [acres] Enter Wetlands  [acres] Enter Wetlands [acres] Enter time step: 15-min Enter data type: Reduced or historic  Select "Compute total area" Enter time series file name  BG-IN1  Name of inflow time series, default *.TSF  Select "Compute total area" Enter time series file name  BG-IN1  Name of inflow time series, default *.TSF  Select "Compute time series", Overwrite file, press "F10" to view information.  Press "Enter" to return to main menu  Step 4) Determine the design overflow volume  For off-line (high flows bypass the facility) sand filters the design overflow volume is zero and a flow splitter diverts flows above 60% of the 2-yr peak discharge 15 min time steps.  For the on-line (all flows go through the sand filter pond) sand filters, the  On-line or off-line sand filter?  At the KCRTS main menu, select "Enter the analysis TOOLS module," then "Compute VOLUME discharge" Enter time series file Enter end date  8G-IN1  107/10 0.00  Required 10/1/0 0.00  Required 10/1/0 0.00  Required 10/1/0 0.00  Require	Project:		
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Basic or Large Sand Filter? %runoff volume to be treated 90% for basic and 95% for large  Step 2) Determine rainfall region and regional scale factor. Rainfall Region: Landsburg or Seatac? Regional Scale Factor:  (unitless)  Required Figure 3.2.2.A Regional Figure 3.2.2.A Required Figure 3.2.2	Sten 1) Determine whether a basic or lar	rge sand filter is need	ed
Step 2) Determine rainfall region and regional scale factor.   Rainfall Region: Landsburg or Seatac?   (unitless)   Required Figure 3.2.2.A   Regional Scale Factor:   (acres)   (acre			
Step 2) Determine rainfall region and regional scale factor.  Rainfall Region: Landsburg or Seatac? (unitless) Required Figure 3.2.2.A regional Scale Factor: (unitless) "  Step 3) Create inflow time series  If the sand filter is upstream of detention, the time series is that of the developed site. If the sand filter is downstream of detention, the time series is that leaving the detention pond. In KCRTS at the main menu, select "CREATE a new time series" to generate the inflow time series Select project location Seatac or Landsburg (acres) Enter Till Pasture (acres) Enter Till Pasture (acres) Enter Till Grass (acres) Enter Till Grass (acres) Enter Outwash Forest (acres) Enter Outwash Pasture (acres) Enter Outwash Grass (acres) Enter Wellands (acres) Enter Wellands (acres) Enter scale factor (acres) Enter data type: Reduced or historic Select "Compute total area" Enter time series file name Select "Compute time series", Overwrite file, press "F10" to view information. Press "Enter" to return to main menu Step 4) Determine the design overflow volume  For off-line (high flows bypass the facility) sand filters the design overflow volume is zero and a flow splitter diverts flows above 60% of the 2-yr peak discharge 15 min time steps. For the on-line (all flows go through the sand filter pond) sand filters, the On-line or off-line sand filter?  At the KCRTS main menu, select "Enter the analysis TOOLS module," then "Compute VOLUME discharge" Enter time series file BG-IN1 Name data file, default *.PRN Required 10/1/0 0:00 Required 9/30/8 23:59 Select "Extract discharge volume" Note "Discharge Volume" (V <sub>d</sub> ) results Select "Extract discharge volume" Note "Discharge Volume" (V <sub>d</sub> ) results Select "Extract discharge volume" (V <sub>d</sub> ) results Select "Extract discharge volume" Note "Discharge Volume" (V <sub>d</sub> ) results Select "Extract discharge volume" (V <sub>d</sub> ) (S <sub>d</sub> ) (Oct T	<u> </u>		
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Select "Compute time series", Overwrite file, press "F10" to view information. Press "Enter" to return to main menu  Step 4) Determine the design overflow volume  For off-line (high flows bypass the facility) sand filters the design overflow volume is zero and a flow splitter diverts flows above 60% of the 2-yr peak discharge 15 min time steps.  For the on-line (all flows go through the sand filter pond) sand filters, the  On-line or off-line sand filter?  At the KCRTS main menu, select "Enter the analysis TOOLS module," then "Compute VOLUME discharge" Inflow hydrograph previously named Enter output time series file  Enter output time series file  Enter start date  Enter end date  Select "Extract discharge volume"  Note "Discharge Volume" (V <sub>d</sub> ) results % runoft volume to overflow (%V <sub>f</sub> )  Calc. design overflow volume = %V <sub>ff</sub> *V <sub>d</sub> (acft)  Maximum overflow volume			
Step 4) Determine the design overflow volume  For off-line (high flows bypass the facility) sand filters the design overflow volume is zero and a flow splitter diverts flows above 60% of the 2-yr peak discharge 15 min time steps.  For the on-line (all flows go through the sand filter pond) sand filters, the  On-line or off-line sand filter?  At the KCRTS main menu, select "Enter the analysis TOOLS module," then "Compute VOLUME discharge" Inflow hydrograph previously named Enter time series file  Enter time series file  BG-IN1  Name data file, default *.PRN  Enter start date  Enter end date  Select "Extract discharge volume"  Note "Discharge Volume" (V <sub>d</sub> ) results % runoff volume to overflow (%V <sub>n</sub> )  Calc. design overflow volume = %V <sub>n</sub> * *V <sub>d</sub> Maximum overflow volume			
For off-line (high flows bypass the facility) sand filters the design overflow volume is zero and a flow splitter diverts flows above 60% of the 2-yr peak discharge 15 min time steps.  For the on-line (all flows go through the sand filter pond) sand filters, the  On-line or off-line sand filter?  At the KCRTS main menu, select "Enter the analysis TOOLS module," then "Compute VOLUME discharge" Inflow hydrograph previously named Enter output time series file  Enter output time series file  Enter start date  Enter start date  Enter end date  Select "Extract discharge volume"  Note "Discharge Volume" (V <sub>d</sub> ) results % runoff volume to overflow (%V <sub>rf</sub> )  Calc. design overflow volume = %V <sub>rf</sub> *V <sub>d</sub> (acft)  Maximum overflow volume	Press "Enter" to return to main men	nu	formation.
and a flow splitter diverts flows above $60\%$ of the 2-yr peak discharge 15 min time steps. For the on-line (all flows go through the sand filter pond) sand filters, the  On-line or off-line sand filter?  At the KCRTS main menu, select "Enter the analysis TOOLS module," then "Compute VOLUME discharge" Inflow hydrograph previously named Enter output time series file  Enter start date  Enter start date  Enter end date  Select "Extract discharge volume"  Note "Discharge Volume" ( $V_d$ ) results  % runoff volume to overflow (% $V_{rf}$ )  Calc. design overflow volume = % $V_{rf}$ * $V_d$ (acft) Maximum overflow volume  (acft) Maximum overflow volume	<b>Step 4) Determine the design overflow vertical example 1</b>	<u>olume</u>	
For the on-line (all flows go through the sand filter pond) sand filters, the  On-line or off-line sand filter?  At the KCRTS main menu, select "Enter the analysis TOOLS module," then "Compute VOLUME discharge" Enter time series file  Enter output time series file  Enter start date  Enter start date  Enter end date  Select "Extract discharge volume"  Note "Discharge Volume" ( $V_d$ ) results % runoff volume to overflow (% $V_{ff}$ )  Calc. design overflow volume = % $V_f$ " $V_d$ (acft)  Maximum overflow volume	For off-line (high flows bypass the facility) san	d filters the design overfl	ow volume is zero
On-line or off-line sand filter?  At the KCRTS main menu, select "Enter the analysis TOOLS module," then "Compute VOLUME discharge" Enter time series file  Enter output time series file  Enter start date  Enter end date  Select "Extract discharge volume"  Note "Discharge Volume" ( $V_d$ ) results % runoff volume to overflow ( $V_f$ )  Calc. design overflow volume = $V_f$ * $V_d$ (acft)  Maximum overflow volume	and a flow splitter diverts flows above 60%	of the 2-yr peak discharg	ge 15 min time steps.
At the KCRTS main menu, select "Enter the analysis TOOLS module," then "Compute VOLUME discharge" Inflow hydrograph previously named Enter output time series file $\frac{BG-IN1}{BG-IN1} \qquad \text{Inflow hydrograph previously named} \\ \text{Enter start date} \qquad \frac{BG-IN1}{10/1/0  0:00} \qquad \text{Required } 10/1/0  0:00 \\ \text{Enter end date} \qquad \frac{9/30/8  23:59}{23:59} \qquad \text{Required } 9/30/8  23:59 \\ \text{Select "Extract discharge volume"} \\ \textit{Note "Discharge Volume" (V_d) results} \qquad \text{(acft)} \qquad \text{Inflow volume} \\ \textit{% runoff volume to overflow (%V_f)} \qquad \qquad \text{(%)} \qquad 10\% \text{ for basic; } 5\% \text{ for large (Step 1)} \\ \textit{Calc. design overflow volume} = \text{\%V}_f \text{\%V}_d \qquad \text{(acft)} \qquad \text{Maximum overflow volume}$	For the on-line (all flows go through the sand fi	lter pond) sand filters, th	e
Enter time series file $BG-IN1$ Inflow hydrograph previously named Name data file, default *.PRN Enter start date $10/1/0 0:00$ Required $10/1/0 0:00$ Required $9/30/8 23:59$ Select "Extract discharge volume" Note "Discharge Volume" ( $V_d$ ) results % runoff volume to overflow ( $V_f$ ) (acft) Inflow volume $V_f$ (acft) Maximum overflow volume $V_f$ (acft) Maximum overflow volume			
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Enter output time series file $BG-IN1$ Name data file, default *.PRN Enter start date $10/1/0 - 0.00$ Required $10/1/0 - 0.00$ Required $9/30/8 - 23.59$ Select "Extract discharge volume" Note "Discharge Volume" ( $V_d$ ) results % runoff volume to overflow ( $V_f$ ) (acft) Inflow volume $V_f$ (acft) Maximum overflow volume $V_f$ (acft) Maximum overflow volume			
Enter start date $\frac{10/1/0  0.00}{9/30/8  23.59}$ Required 10/1/0 0:00 Required 9/30/8 23:59 Required 9/30/8 23:59 $\frac{10/1/0  0.00}{9/30/8  23.59}$ Required 9/30/8 23:59 $\frac{10/1/0  0.00}{9/30/8  23.59}$ Required 9/30/8 23:59 $\frac{10/1/0  0.00}{10/1/0  0.00}$ Required 10/1/0 0:00			
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Calc. design overflow volume = $%V_{rf}^*V_d$ (acft) Maximum overflow volume	· -/		
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## In KCRTS at the main menu, select "Size a Facility" Enter R/D Facility (filename) BG-SF1 Automatically \*.RDF Switch to "Manual" Design Technique Select "Create a new R/D Facility," then select "Infiltration Pond" Enter side slope Horizontal component Enter bottom area (sqft) 0r bottom length (ft) bottom width (ft) Enter effective storage depth before overflow (ft) Enter Elevation at 0 stage (ft) Enter Vertical permeability (min/in) Toggle to desired bottom surface Permeable Required Toggle to desired side surface Impermeable Required Enter Riser Head (ft) Enter Riser Diameter (in) 12-36" See 6.5.2.2 and 5.3.1.1 Enter Number of orifices Select top of riser flat Select "Point of Compliance" Enter inflow time series name BG-IN1 Select "Return to Facility Edit" Skip Test Hydrograph List and Define Riser Orifices and Notch Select "Save to \*.rdf" Step 7) Route inflow time series through sand filter and compare volumes Select "MODIFY auto Analysis setup" Toggle to "Skip Peaks" from "Calculate Peaks" Toggle to "Do not Notify" from "Notify" Leave Duration Calcs? Prompt at default "Skip Durations" Toggle to "Calculate Volume" from "Skip Volume" Select "Edit peak/Duration/Volume Information" Enter start date Required 10/1/0 0:00 10/1/0 0:00 Enter end date 9/30/8 23:59 Required 9/30/8 23:59 Select "Return to facility Design Menu" Select "OVERWRITE File" Select "Route Time series & perform auto analysis" Press "F10" to display routing data, then press return again for volume calculation Press "F10" to view volume results when R/D Facility menu displays. Press "Enter" to return to R/D facility menu. KCRTS will display the time series flow volume. Compare the discharge Sand Filter Discharge volume with design overflow volume calculated in Step 4. If outflow volumes Area (sqft) Volume (ac-ft) exceed design, the filtered volumes do not meet the treatment goal Target= requirement and increase sand area and/or pond volume and route again. If outflow volumes significantly exceed design, decrease sand area and/or pond volume and route again. If outflow volumes do not exceed design, the treatment goal requirements are met. To Adjust Sand Filter Geometry, Re-route Flows and Re-check Flow Volumes Select "Edit facility" at R/D Facility menu Edit data to change facility, then select "save to \*.rdf" Select "Overwrite File" Select "Route time series and perform auto analysis"

Step 5) Define sand filter modeling parameters and Step 6) Size the sand filter

	Step 8	8)	Size	the	underd	lrain	system
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* For feeder pipes, the design criteria in "underdrain systems"(6. * The collector pipe shall be sized to convey the 2-year 15-minut	
the upstream invert. Capacity can be checked using the "KCBW KCRTS dev., 2-yr peak flow (15-min steps) (cfs	" standard step back water program.
Size Summary: Volume, Land area, and Cross Section	
The land needed includes area for the pond, berms, access, and	setbacks (6.2.3).
$A_{top}$ =Pond top area. If Square, $(A_{sf}^{0.5}+2dZ)^2$ (sf)	"A <sub>sf</sub> " from Step 5 and "d" from Step 3
Z= side slope length per unit height (un	itless) Select now
Total volume equals volume of ponded water $(V_{wq})$ plus volume	to convey the 100-yr flow.
$V_{wq} = (A_{top} + A_{sf})d/2$ ponded water volume (ft <sup>3</sup> )	
Cross-section includes underdrain system, sand depth (1.5 ft), pe	ond depth ("d," max 6 ft), and freeboard